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FOREST INSECT INVESTIGATIONS

ANNUAL REPORT OF STUDIES OF
THE MOUNTAIN PINE BEETLE INFESTATION ON THE
BEAVERHEAD NATIONAL FOREST

1931

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February 8, 1932

For information of

Mr. Keen

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Respectfully submitted,

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REPORT OF THE SURVEYS OF THE MOUNTAIN PINE BEETLE
ON THE BEAVERHEAD NATIONAL FOREST
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INTRODUCTION

The suppression of mountain pine beetle epidemics requires not only a method of treatment, but a fundamental knowledge relative to the application of control is essential if success is to be assured. On all thoughts of control one of the outstanding needs is a better knowledge of the behavior of such epidemics. To secure such information a study of the Beaverhead infestation was instituted in 1929. From this study, which consisted of an annual survey of all infested areas, it was hoped that data relative to the severity of the annual losses, rates of increases, spread, sources of infestation, as well as the flight habits of the insects themselves, would be forthcoming. This study will be continued as long as the outbreak persists. In 1931 a study of the duration of the period of attack was instituted.

Prior to the year 1928 surveys of the Beaverhead infestation were conducted for the purpose of furnishing an estimate of the number and location of infested trees in order to properly plan control measures. In 1928 the tremendous increase in the number of infested trees over the previous season's loss placed the control project in an uneconomical light and it was dropped. The data from these early surveys, though secured for a different purpose and complicated by control work, has been of value in completing the information secured under the present study.

PRESENT STATUS OF THE PROJECT

In 1925 it was found that the mountain pine beetle epidemic on the Bitterroot had crossed the Continental Divide into Montana and was established in the lodgepole pine stands of the Big Hole Basin. Control was instituted in 1926 and the two subsequent years, but was discontinued after 1928 due to the project having become uneconomical.

Since instituting this survey, the project has been enlarged until in 1930 it embraced the entire original boundary of the Beaverhead National Forest. Extending the boundaries of the units to embrace the more inaccessible country and to include the entire original forest boundary in the survey was completed in 1930 and the report for that year gives the revisions and necessary explanations to make all data comparable.

Three additions have been made to the 1931 report. The data secured from the surveys of Sheep Canyon and Upper Blacktail Creek in 1931 are included due to the important bearing they have on the flight habits of the insect. The other two additions concern studies of the habits of attack of the mountain pine beetle.

Inspection of the survey data for the entire forest up to the present season shows a gain for 1931 greatly in excess of that for the preceding year. The tabulation which follows should give a clearer conception of the total annual increase.

INCREASE IN MOUNTAIN PINE BEETLE INFESTATION
BEAVERHEAD NATIONAL FOREST

Number of Attacked Trees in	<u>1927</u>	<u>1928</u>	<u>1929</u>	<u>1930</u>	<u>1931</u>
	67,791 (1)	321,272	2,098,873	3,859,276	12,238,732
Increase in No. of Infested Trees in	<u>1928 over 1927</u>	<u>1929 over 1928</u>	<u>1930 over 1929</u>	<u>1931 over 1930</u>	
		1,762,851	1,760,403	8,402,774	
Per cent of Increase	374	553	84	217	

(1) Estimate considered to have been too conservative.

The figures given for 1927 are for the original unit acreage while those for succeeding years give the larger figures pertaining to the increased acreages. The revision of the 1927 estimate of attacks was not repeated in this report due to the belief it would create an estimate of uncertain value. However, the distribution of the infestation was more even in subsequent years and the revised estimates for them probably closely approach actual figures. Leaving the 1927 estimate untouched and revising that for 1928 also gives an inflated value for the per cent of increase from 1927 to 1928.

A more detailed estimate of the attacked trees on each unit is given in Tables I and II.

TABLE I

SUMMARY SHEET - BEAVERHEAD FOREST SURVEY - 1931
MOUNTAIN PINE BEETLE IN LODGEPOLE PINE COMPARISON OF INFESTATION
FROM 1927 TO 1931

Unit	1927 Survey :				Subsequent Surveys				
	Acreage :	Trees :	Trees :	Revised :	Attacked		Trees		
		Treated :	per Acre :	Acreage :	1928 :	1929 :	1930 :	1931 :	
Pintlar	: 21,760 :	11,527 :	.530 :	61,600:	30,815 :	274,834 :	440,403 :	487,943:	
Mussigbrod	: 20,480 :	12,479 :	.610 :	56,300:	62,940 :	262,402 :	508,483 :	908,994:	
Battlefield	: 37,120 :	3,454 :	.093 :	102,400:	43,816 :	467,636 :	1,006,586 :	3,114,270:	
West Side	: 33,280 :	-- :	-- :	76,500:	29,897 :	210,521 :	457,655 :	1,543,978:	
Jackson	: 28,160 :	2,908 :	.103 :	75,800:	37,519 :	193,114 :	504,449 :	1,102,561:	
Bloody Dick	: 61,440 :	-- :	-- :	108,160:	29,491 :	167,107 :	245,724 :	1,291,642:	
Horse Prairie	: 24,320 :	-- :	-- :	57,000:	11,673 :	150,765 :	34,200 :	140,352:	
Rattlesnake	: 48,000 :	-- :	-- :	68,400:	3,694 :	14,706 :	7,990 :	108,565:	
Grasshopper	: 41,600 :	-- :	-- :	42,500:	552 :	3,273 :	11,900 :	88,853:	
Warm Springs	: 51,200 :	-- :	-- :	54,500:	20,165 :	86,819 :	113,277 :	1,111,319:	
East Side	: 49,280 :	21,110 :	.428 :	86,200:	35,208 :	210,136 :	415,172 :	1,509,164:	
Upper Wise River:	144,000 :	-- :	-- :	142,800:	9,425 :	16,850 :	24,463 :	405,350:	
Lower Wise River:	61,440 :	3,567 :	.058 :	59,000:	6,077 :	25,960 :	65,556 :	230,690:	
Melrose	: -- :	-- :	-- :	132,700:	-- :	-- :	10,368 :	132,965:	
Lima	: -- :	-- :	-- :	218,000:	-- :	14,750 :	12,950 :	62,086:	
Totals	622,080 :	55,045 :	.088 :	1,341,860:	321,372 :	2,084,123 :	3,835,958 :	12,238,732:	

TABLE II

COMPARISON OF ATTACKED TREES PER ACRE AND PER CENT OF
INCREASE EACH YEAR FOR PERIOD 1927 TO 1931. BEAVERHEAD FOREST
SURVEY - MOUNTAIN PINE BEETLE IN LODGEPOLE PINE - 1931

Unit	1927		1928		1929		1930		1931	
	: Attacked	: % Change	: Attacked	: % Change	: Attacked	: % Change	: Attacked	: % Change	: Attacked	: % Change
	: Trees per	: over Pre-	: Trees	: over Pre-	: Trees	: over Pre-	: Trees	: over Pre-	: Trees	: over Pre-
	: Acre	: vious year	: per Acre	: vious year	: per Acre	: vious year	: per Acre	: vious year	: per Acre	: vious year
Pintlar	: .530	: --	: .500	: - 6	: 4.462	: 792	: 7.150	: 60	: 7.921	: 11
Mussigbrod	: .610	: --	: 1.118	: 83	: 4.661	: 317	: 9.033	: 93	: 16.146	: 79
Battlefield	: .093	: --	: .428	: 360	: 4.567	: 967	: 9.830	: 115	: 30.413	: 209
West Side	: --	: --	: .391	: --	: 2.752	: 604	: 5.982	: 117	: 20.183	: 237
Jackson	: .103	: --	: .495	: 380	: 2.548	: 415	: 6.655	: 161	: 14.546	: 119
Bloody Dick	: --	: --	: .273	: --	: 1.545	: 467	: 2.271	: 47	: 11.942	: 426
Horse Prairie	: --	: --	: .205	: --	: 2.644	: 1192	: .600	: -77	: 2.462	: 310
Rattlesnake	: --	: --	: .054	: --	: .216	: 298	: .117	: -46	: 1.587	: 1259
Grasshopper	: --	: --	: .013	: --	: .077	: 493	: .280	: 264	: 2.091	: 647
Warm Springs	: --	: --	: .370	: --	: 1.593	: 331	: 2.078	: 30	: 20.391	: 881
East Side	: .428	: --	: .408	: - 5	: 2.438	: 497	: 4.816	: 98	: 17.508	: 263
Upper Wise River:	: --	: --	: .066	: --	: .118	: 79	: .171	: 45	: 2.838	: 1557
Lower Wise River:	: .058	: --	: .013	: -78	: .440	: 327	: 1.111	: 153	: 3.906	: 252
Melrose	: --	: --	: --	: --	: --	: --	: .078	: --	: 1.002	: 1182
Lima	: --	: --	: --	: --	: .068	: --	: .059	: -12	: .290	: 379
Averages	: .088	: --	: .321	: 265	: 1.724	: 437	: 2.876	: 67	: 9.121	: 217

In Tables I and II the figures for 1927 include only the trees treated. An estimate of the untreated trees left on the units would be subject to such a large error that it was considered advisable to eliminate it from this report.

The preceding two tables show that both per cent and numerical increase in infestation were very great in 1931 when compared with 1930. In 1930 the gain in the number of infested trees was about 1,750,000. In 1931 the gain was about 8,400,000 trees or nearly five times as much as for the preceding year.

Owing to the infestation having become general in 1931 on the forests to the north and west as well as over the entire Beaverhead Forest, any attempt to connect one source with a certain proportion of the gain would be subject to considerable error. There are three known sources which probably contributed to the 1931 infestation on the Beaverhead, and they are the Bitterroot and Idaho epidemics and local infestation. Increase from local infestation is believed by the writer to have been a much larger factor in the 1931 gain than in any previous year. Lack of definite data, however, prevents the assignment of any comparative weight to the amount of increase from any source.

The units bordering on the Idaho or Bitterroot epidemics in general show the heaviest losses to date from the mountain pine beetle. Other units, more remote from these two sources are showing rapid increase in infestation. To aid in visualizing the conditions that have resulted from the presence of the infestation on the Beaverhead Forest from 1927 to 1931, Table III has been prepared, giving the total number of trees killed per acre on different units during that period.

TABLE III

TREES KILLED PER ACRE ON EACH UNIT BY THE MOUNTAIN PINE BEETLE
PERIOD 1927 TO 1931
BEAVERHEAD NATIONAL FOREST

<u>Unit</u>	<u>Trees Killed per Acre 1927-1931</u>	<u>Unit</u>	<u>Trees Killed Per Acre 1927-1931</u>
Pintlar	20.813	Grasshopper	2.474
Mussigbrod	31.917	Warm Springs	24.452
Battlefield	45.431	East Side	25.778
West Side	29.455	Upper Wise River	3.200
Jackson	24.354	Lower Wise River	5.538
Bloody Dick	16.131	Melrose	1.080
Horse Prairie	6.151	Lima	.417
Rattlesnake	1.974		
		Average Loss Over Entire Forest	13.876

The preceding table gives some indication of the losses per acre but is deficient in its failure to show how many trees per acre, susceptible to mountain pine beetle attacks, were present on the unit prior to the epidemic. For example, on the part that is timbered there is probably as large a proportion of the stand killed on the Horse Prairie Unit as on the Bloody Dick Unit, but the latter has a much larger proportion of timbered area and, consequently, a higher average stand per acre. The unit having the smaller timbered acreage will probably show less final loss per unit of area. Lima Unit can never show a very high loss per acre because it has the smallest proportion of timbered area of any unit.

STATUS OF THE INFESTATION ON EACH UNIT

The more detailed discussion following, Tables I and II, the appended map, and Chart I should aid in a clearer understanding of conditions on each unit.

Pintlar Unit

Pintlar Unit showed only a slight increase in attacked trees in 1931 over the number for the previous year. Two factors are believed to be chiefly responsible for only this slight gain. The heavy infestation already present on the area prevents any but an extremely heavy inflow of beetles from influencing the annual number of trees attacked. The second major factor is the increasing remoteness of the Pintlar Unit from the most active part of the infestation.

Mussigbrod Unit

Tables I and II and Chart I show the Mussigbrod Unit still gaining in the number of attacked trees. This unit's comparative nearness to the active part of the Bitterroot epidemic indicates that it may have received much of its infestation from that source during the 1931 season, but it is also quite possible that local increase is responsible for the majority of, or even the entire gain. In 1930 this unit showed the greatest total loss per acre on the Beaverhead Forest. In this respect the Battlefield Unit supplanted it in 1931 and Table III shows four other areas with losses now only slightly less than for the Mussigbrod Unit.

Battlefield Unit

The Battlefield Unit again showed the largest total gain of any area on the forest. Slightly more than 25 per cent of the 1931 infestation on the Beaverhead Forest is present on that area. The Bitterroot epidemic is thought to have been responsible for much of its infestation, but local increase is doubtless becoming a major factor in the gains on that area. Tables I and II and Chart I are arranged so that losses for this and other units may be readily compared.

About 41 per cent of the total number of trees killed on the Beaverhead Forest from 1927 to 1931 have been on the Pintlar, Mussigbrod and Battlefield Units. The losses for that period on the Battlefield Unit alone account for approximately 25 per cent of the number of trees killed.

It is felt by the writer that the peak of loss on the Battlefield Unit has already been reached and that the 1932 attacks will be fewer than in 1931. This statement is based on the impression gained by the writer that approximately 40 per cent of the number of trees on that unit have already been killed. The remainder of the stand is made up chiefly of the smaller diameter classes which are not susceptible to or else offer considerable resistance to attack by the mountain pine beetle.

West Side Unit

Adjoining the Battlefield Unit on the south is the West Side Unit. The latter area probably received much of its 1931 infestation from the Idaho and Bitterroot epidemics, but local increase is most likely gaining

in importance. This area shows a slightly higher per cent of increase than the Battlefield Unit and ranks the third highest on the forest in total loss per acre up to the present time. See Tables I and II and Chart I for comparison with other units.

Jackson Unit

This unit showed an increase below the average for the forest. Assignment of a definite reason for this is impossible but two alternatives are offered in explanation. Few, if any, beetles may have invaded this area from outside sources and local increase may have been the only cause of gain, or else a heavy flight of beetles from this unit could have neutralized much of the effect of a heavy invasion from outside sources. Chance may play an important role in the invasion of an area by barkbeetles; otherwise, it seems impossible to assign a definite reason to the invasion of one area by barkbeetles and the failure to infest an adjoining one.

Probably both the Jackson and West Side Units will continue to show increasing losses during the next year or two, due to their heavy stands of lodgepole pine.

Bloody Dick

Nearly double the average increase in infestation for the entire forest occurred on this unit in 1931. It is not believed losses on this area will ever total as high per acre as on either the Jackson or West Side Units, due to the more scattered nature of the stand. Idaho probably was the source of much of the 1931 infestation.

Horse Prairie Unit

The losses in 1931 on this unit do not indicate a very heavy beetle invasion from outside sources. The scattered nature of the timber stands precludes losses ever averaging as much per acre as on the more heavily timbered units to the north. Tables I and II and Chart I indicate the infestation has varied considerably during the period it has been observed.

Lima Unit

The Lima Unit with only 32,000 of its 218,000 acres timbered, showed an increase in infestation in 1931. It would not take many years of attack as heavy as in 1931 to complete the destruction of all susceptible timber on that unit, as the timber areas are small, scattered, and contain a high proportion of tree species not attacked by the mountain pine beetle.

Outside sources were probably the cause of the greater part of the infestation in 1931.

Rattlesnake Unit

Although containing a considerable proportion of unsusceptible timber, and open country, this unit has some extensive areas of lodgepole pine. Increase in infestation on this unit was extremely high in 1931 probably due to influx of insects from nearby more heavily infested units or possibly even from more distant sources. This unit and those nearby can be expected to show increasing losses for a number of years.

Melrose Unit

The Melrose Unit is fairly similar in stand character to the Rattle-

snake Unit, differing only in having more extensive stands of pure lodge-pole pine, and a larger proportion of susceptible species. Invasion by insects from other forests or the heavily infested units to the west probably accounts for the greater part of the heavy gain in infestation on this unit in 1931.

Grasshopper Unit

This area showed a heavy gain in infestation in 1931 although the number of attacked trees per acre can still be considered light. The much greater gain in infestation on all nearby units to the east, north, and south can only be explained by variations in the flights of insects, probably either from the heavily infested units to the west and north, or else from other more distant sources. It seems just a matter of chance that more insects did not invade the Grasshopper Unit.

Upper Wise River Unit

The ratio of increase in 1931 was the greatest on the Upper Wise River Unit of any on the forest. The exact source of this increase is only conjectural - there being a possibility of the insects coming from distant infestations, but more likely they came from the heavily infested units to the north and west. Probably losses will continue to increase on this unit for a number of years.

Warm Springs Unit

Only by a heavy invasion of insects can the large increase in infestation on this unit be explained. The source may have been outside the Beaverhead Forest, or have been the more heavily infested units to the

west and northwest.

East Side Unit

In Tables I and II and Chart I it may be noted that, compared with adjacent areas, the East Side Unit did not exhibit as great a per cent of gain in attacked trees in 1931. This slight increase may have been due to the heavy losses on the East Side Unit in the preceding years and the small amount of remaining host material. Judging ^{by} the number of trees killed per unit of area up to the present time, the East Side Unit has sustained the fourth heaviest loss of all the units; for 1931 it possessed the third highest total infestation of any unit on the forest. The source of the 1931 infestation is not definitely known and, while either sources outside the forest or the units to the west and north could have been the chief contributors, most of the infestation may have been the result merely of local increase. The average increase on the East Side Unit for 1931 is slightly more than for the entire forest.

Lower Wise River Unit

The gain in infestation on this unit was but slightly higher than the average for the entire forest. Losses have not been very heavy to date on this unit and it is probable that the infestation will show big gains in the future. If any insects invaded this area, they may have come from outside the forest but the more likely source would seem to be the adjoining East Side Unit.

GENERAL STATUS OF THE BEAVERHEAD INFESTATION

Losses on the Beaverhead, including those of 1931, have been confined chiefly to the larger lodgepole pine. It is believed the timber killed up to the present time will average about nine inches in diameter breast high and contain about fifty board feet of merchantable timber per tree. On that basis the approximate 18,500,000 trees killed on the Beaverhead Forest up to the present time indicate that close to 925,000,000 board feet have been destroyed. The estimate furnished by the Beaverhead Forest of the merchantable stand of susceptible timber on the original Beaverhead Forest is given as 1,270,659,000 board feet which includes lodgepole pine, white-bark pine, and limber pine. It is doubtful if this estimate of the original stand includes timber less than ten inches in diameter breast high, while the estimate of losses from the mountain pine beetle includes many trees below that diameter. Comparing the figures shown for the original stand and losses caused by the beetles, gives an estimate of the destruction of approximately 75 per cent of the merchantable timber on the forest up to the present time. That estimate is probably high. Deducting for the large number of trees killed that are under ten inches in diameter breast high, it is believed a 50 per cent loss of the merchantable stand is nearer the correct amount. Most of the merchantable timber having been killed on the heavily infested units, future losses on these areas will probably be confined chiefly to the smaller diameter trees not included in the stand estimate and consequently

will affect it but little. This is especially true of the stand on the units in the northern and western portions of the forest. In the eastern and southern parts the infestation is still comparatively light and much timber that would be classed as merchantable is still unattacked. In the Big Hole Basin and the Wise River Drainage about 16,000,000 of the total loss on the forest of 18,500,000 trees have been killed. This indicates how heavily these areas have been hit and the probable small amount that remains of the timber that can be classed as merchantable.

MOUNTAIN PINE BEETLE FLIGHT

One of the objects of the annual Beaverhead Survey is to gain some idea of the ability of the mountain pine beetle to make long and sustained flights. In 1930 the possibility of this insect invading the timbered areas of Blacktail Creek and thus endangering the vast timber stands to the west and south led to the institution of an insect survey on the Blacktail Drainage. The survey showed apparently a heavy flight of beetles into the Sheep Canyon area in 1929 and a lighter infestation on the three forks of Blacktail Creek. The character of the infestation indicated that heavily infested areas on the Beaverhead or Salmon Forests were the sources of the invading insects, the nearest of which are about 25 miles away. Control work was instituted in 1931 on the aforementioned areas. In the fall of 1931 the survey of the previous year was duplicated. The newly attacked trees found on the areas indicated again that outside sources were responsible for at least a large part of the infestation. To aid in visualizing the conditions found on the area, the following table has been prepared giving the data for the trees treated in 1930.

the estimated number left, and the 1931 infestation. Map I gives the possible sources of both infestation and direction of flight of insects invading the Sheep Canyon and Upper Blacktail Creek areas. The distances given are between untimbered areas or between areas of unsusceptible timber, which must be traversed by the beetles to reach the distant host material.

TABLE IV
STATUS OF THE MOUNTAIN PINE BEETLE
INFESTATION ON BLACKTAIL CREEK
IN 1930 AND 1931

Area	: No. of Trees : : Treated in 1931 :	Probable No. of Trees Left in 1931 :	Trees Attacked in 1931
Sheep Canyon	: 3,045 :	500 :	23,183
W. Fk. Blacktail	: 971 :	250 (1) :	3,200
Mid. Fk. "	: 196 :	:	350
E. Fk. "	: 641 :	200 (2) :	2,050
Clover, Wolverine, : West and Middle Creeks	: : :	: : :	1,375 (3)
	4,853	950	30,158

- (1) Includes one group of 45 trees.
- (2) Includes large untreated area.
- (3) Included in West and East Forks in 1930.

From Table IV it may be seen that the 1931 infestation in the Sheep Canyon area is so great an increase over that of the previous season as to quite definitely point to an influx of beetles. Indications are that the same influx occurred on the upper Blacktail Drainage but not to

the extent that it took place in Sheep Canyon. It is planned to make the survey of these areas annually to secure more data on the migrating ability of the mountain pine beetle.

DATA FROM THE REPEATED EXAMINATION
OF TWO SAMPLE STRIPS DURING 1931

For a number of years it has been realized that between the initial and final attacks of the mountain pine beetle, there is considerable lapse of time. It was not thought until recently, however, that the proportion of infestation occurring subsequent to the first three or four weeks of attack was very great. An increasing knowledge of parent adult emergence and observation of many attacks late in the season indicated that the proportion of infestation occurring in late summer might be greater than was at first supposed. It became important that more definite information be secured, first to measure the reliability of survey data secured at different times during the season of attack and, second, where fall control is planned, to know the proportion of the attacked trees that would probably be controlled on an area if treatment were begun on a certain date. If an appreciable amount of infestation occurred subsequent to the initiation of an insect survey, it would be found that strips run prior to the cessation of attack would show less than the total number of attacks, necessitating applying a correction factor to permit comparisons of data secured both early and late in the season on an equal basis.

With the preceding information and considerations in mind, it was decided to run two strips, one on a lightly, and the other on a heavily infested area, on the Beaverhead National Forests. Strips showing two

degrees of severity of attack were selected as it was thought a difference might exist in the rate of attack on the two areas.

These strips were to be examined at the beginning of the survey of the Beaverhead infestation and reexamined approximately every two weeks until September 1st, again about the end of September, and finally at the conclusion of the survey.

The data obtained was then to be plotted in such a manner that strips run on any date on the Beaverhead survey could be corrected to show the final number of attacks.

The strips were run as planned, an area one chain wide and $4\frac{1}{2}$ miles long being examined on each of the Battlefield and Lower Wise River Units. Each time the strips were run, the trees attacked since the preceding examination were blazed, and the number recorded for each ten-chain interval. Any tree having two attacks was counted as an attacked tree. For that reason the figures for attacked trees per acre are probably higher than the actual mortality that will occur on the strip. There is also a possibility that there may be a greater proportion of pitched out attacks occurring during the latter part of the season than in the earlier part. At least trees lightly attacked late in the season are less likely to be killed by secondary insects than trees infested earlier in the season.

The abnormally long season of 1931, and the possibility of its greatly affecting the length of the period of attacks, makes it unsafe to consider the data presented as applying to more than the season of 1931. Further, the drought conditions which have existed, especially during the past season, may have lowered the resistance of the trees and thus have

affected the length of the period of attack and the proportion of insects making more than one attack. In explanation of the preceding statement, there is a possibility that lowered resistance of trees favors more rapid gallery construction and possibly an earlier and a larger proportion of parent adult emergence. Finally, there is a possibility that the strips are too short to be representative of general conditions.

The data for these two strips is, however, presented as it was secured, but subject to the limitations previously mentioned.

To secure the correction factor the data secured from the two strips was plotted, curves drawn, and an average curve made from the two. This average curve was used as the basis for correcting the data for all units. From it, shown in Chart II, the per cent of the total infestation present on any date was secured. As survey of some units was conducted at widely separated intervals it was necessary to use more than one figure in correcting data for such areas. In Table V a few examples of the corrections are given for data secured on different dates.

TABLE V

PER CENT OF THE TOTAL INFESTATION PRESENT ON ANY UNIT OF
THE BEAVERHEAD NATIONAL FOREST ON CERTAIN DATES OF THE YEAR 1931.
MOUNTAIN PINE BEETLE IN LODGEPOLE PINE

<u>Date</u> <u>1931</u>		<u>Per Cent</u> <u>Total Infestation</u>
August	7	60
"	10	65
"	15	72.5
"	20	79
"	25	84
Sept.	1	90
"	15	96
"	30	99
Oct.	5	99
"	30	100

The preceding table indicates the rapid rise in amount of infestation from August 7th to September 1st and the more gradual increase until the final amount is reached in late October. To indicate a little more clearly the influence this habit of extended attack may have on insect survey data and control plans, corrections for the data for all the units for 1931 are presented in Table VI. Before considering the table some of the limitations and possible errors in these data must again be mentioned. The strips may be too short or not representative of true conditions, the arbitrary rule of what constitutes an attacked tree may cause considerable error, and the 1931 season may have been so abnormal as to furnish data greatly at variance with what would be found under average conditions.

TABLE VI

ESTIMATES OF THE INFESTATION PRESENT ON EACH UNIT OF
THE BEAVERHEAD NATIONAL FOREST OBTAINED FROM THE ORIGINAL SURVEY
DATA AND FROM THE REPEATED EXAMINATION OF TWO STRIPS IN 1931
MOUNTAIN PINE BEETLE IN LODGEPOLE PINE

Unit	No. of Trees per Acre		Total Trees on Unit		Increase Due to Revision
	From the Survey	From the Revised Estimate	From the Survey	From the Revised Estimate	
Pintlar	7.921	12.378	487,943	762,485	274,542
Mussigbrod	16.146	23.742	908,994	1,336,675	427,681
Battlefield	30.413	43.415	3,114,270	4,445,696	1,331,426
West Side	20.183	26.556	1,543,978	2,031,534	487,556
Jackson	14.546	18.529	1,102,561	1,404,498	301,937
Bloody Dick	11.942	14.343	1,291,642	1,551,339	259,697
Horse Prairie	2.462	2.932	140,352	167,124	26,772
Rattlesnake	1.587	1.725	108,565	117,990	9,425
Grasshopper	2.091	2.155	88,853	91,587	2,734
Warm Springs	20.391	20.841	1,111,319	1,135,856	24,537
East Side	17.508	17.631	1,509,164	1,519,783	10,619
Lower Wise R.	2.838	2.862	405,350	408,694	3,344
Upper Wise R.	3.906	3.916	230,690	231,068	378
Melrose	1.002	1.016	132,965	134,847	1,882
Lima	.290	.296	62,086	63,344	1,258
Totals and Averages	9.121	12.309	12,238,732	15,402,520	3,163,788

The estimates from the preceding table indicate how great a difference the time of survey may make in the proportion of the infestation observed on a unit. The units surveyed in August, which included most of the very heavily infested areas, show a decided increase in the revised estimate and materially raise the estimate for the entire forest.

In reviewing the main points indicated by this study, the following are outstanding:

- (1) The need of further study of the same phenomenon on a more extensive scale and possibly over a longer period.
- (2) The period of attack is probably of long duration.
- (3) The data secured indicate no great difference in rate of attack on heavily and lightly infested areas.
- (4) The units surveyed in the early part of the season show considerably less than the final number of insects attacking an area.
- (5) Surveys of the infestation on the Beaverhead in previous years probably show a materially lower loss than actually occurred. Especially would this be true of the areas surveyed early in the season, which have usually been those on which the heaviest losses have occurred.

REPEATED ATTACKS BY THE MOUNTAIN PINE BEETLE IN LODGEPOLE PINE

In August of 1931 an experiment was begun at the Battlefield Ranger Station on the Beaverhead National Forest to determine if a certain behavior of parent adults of the mountain pine beetle observed in western white pine, in which they attacked and emerged from more than one host in a season, was duplicated in lodgepole pine. Following the plan outlined for the experiment, the lower fifteen feet of two green lodgepole pine of susceptible size were each enclosed by a screen cage sufficiently large to hold both the tree and three barkbeetle infested logs. The cages prevented the passage of barkbeetles, but failed in the effort to have them exclude ants. The three logs placed in the cage were from trees attacked in 1931 and any parent adults emerging from them would probably attack the caged green tree. After the lapse of a certain period of time, logs

and caged trees were to be examined to secure some index of the ratio of emergence to any subsequent attack. Original plans also called for dismantling the cage at the time the logs were examined, cutting the caged portion of the tree into logs and then caging them with another green lodgepole pine. The object of the second caging experiment was to determine if the insects which emerged from the logs and attacked the first caged tree would emerge from the second host and attack another. Shortage of available time made necessary the modification of this second caging experiment and the use of the one cage for both experiments. In this modification the infested logs were removed and a green log substituted for them. By removing all insects from the cage it was assured that any attacks on the green log would be from parent adults which had emerged from the tree.

The experiment was begun on August 5th and the first intensive examination made on August 24th, the logs being removed from the cage for that purpose. It was found that a large percentage of the parent adults had emerged from the logs and attacked the green tree. Attacks on the tree were numerous and well under way and the comparatively few insects found in the cage were removed and their number and status recorded. The green log substituted for the three infested logs was not attacked by parent adults during the period from August 24th to November 3rd. Some emergence from the tree had occurred during that period showing quite definitely that these insects will attack and emerge from at least two hosts in the same season.

Though the knowledge that some of the parent adults of the mountain pine beetle will attack and emerge from two hosts in one season is

of scientific interest, the determination that a large per cent of the total brood obey this impulse changes the problem to one of considerable economic importance. Unfortunately the data secured in 1931 is insufficient to determine exactly the amount of this duplication of attack. It is, however, quite definitely known that at least 50 per cent of the brood making the attack on the first host emerged and attacked the second host under caged conditions. That this figure of 50 per cent is conservative is indicated by the following observations: (1) Many parent adults which emerged prior to caging the logs would almost certainly have attacked the caged tree had the logs been caged when they emerged. (2) Emergence from the logs was apparently incomplete and many of the parent adults found in them when they were examined would probably have emerged if the examination had been deferred until a later date.

The proportion of parent adults that emerge from the second host is not definitely known. It is not felt that the less than ten per cent emergence estimated from the second host is typical of field conditions. Had the experiment been started early enough to have included the parent adults that emerged from the first host prior to caging, it is felt that the consequent earlier attack on the second host would have been followed by an earlier and greater proportion of emergence from the second host.

The danger of drawing definite conclusions from the data secured in the experiment just discussed is augmented by other factors known to have existed in 1931.

It is generally recognized that the 1931 growing season in the Big Hole Basin was abnormally long and warm. Such conditions would probably

favor more rapid growth and total seasonal development of barkbeetles than would be secured in the average season.

The drought of 1931 was the most extreme of the general dry cycle of recent years and as that probably weakened tree resistance to insects, the effect may have been to hasten gallery construction and emergence of the mountain pine beetle.

Many parent adults overwintered from 1930 to 1931 and probably augmented the number of insects attacking in 1931. It is quite definitely known that overwintering parent adults emerged in sufficient numbers early in 1931 to successfully attack trees prior to the emergence of the 1931 brood.

Caging trees or logs creates artificial conditions for the development of enclosed insect brood. What effect, if any, these conditions would have on the insects is not known. Retarding of growth is conceivable but acceleration seems the most likely result.

A summary of the important features connected with this study are as follows:

- (1) Parent adults of the mountain pine beetle attacked and emerged from two hosts during the 1931 season.
- (2) Indications are quite definite that the proportion of parent adults of the mountain pine beetle emerging from the first host exceeded fifty per cent in 1931.
- (3) The proportion of parent adults emerging from the second lodge-pole pine was decidedly less than from the first.

(4) The 1931 season was unusual in many respects and may have greatly influenced parent adult activity.

(5) The need for a more comprehensive as well as a more detailed study of parent adult emergence.

DATA CONCERNING ADMINISTRATION OF THE SURVEY

The area covered in the 1931 survey is .87 of one per cent of the entire forest acreage as compared with .69 for 1930. Most of this gain, however, must be credited to the survey of the Blacktail Drainage which averaged 3.30 per cent of the total area. Comparing the areas surveyed within the old boundary of the Beaverhead in 1931 and 1930, we find .73 per cent covered in 1931 in contrast to .69 in 1930. Miles of strip per man day were slightly lower in 1931 than in 1930 due to the addition of the Blacktail Drainage survey. Exclusive of that area the average per man day is higher in 1931 than for the preceding year. This was secured in spite of a much heavier infestation which slows up strip running due to more trees to count and also more frequent entries of data.

SUMMARY

The outstanding findings of the 1931 survey were as follows:

(1) An increase from 3,859,276 in 1930 to 12,238,732 infested trees in 1931.

(2) An increase in the per cent of increase from 84 in 1930 to 217 in 1931.

(3) An apparent continuance of the drift of insects from sources outside of the Beaverhead Forest into that area.

(4) An increase in the infestation on all units of the forest.

(5) Additional evidence of flight of the mountain pine beetle over untimbered country to infest an isolated area of lodgepole pine at least 25 miles from the nearest infestation.

(6) Evidence that the period of attack of the mountain pine beetle was a very long one in 1931.

(7) Evidence that this extended attack period is due in part at least to the parent adults emerging from the trees they initially attack and repeating attack, gallery construction and emergence one or more times.

TABLE VII

SUMMARY AND ANALYSIS OF RESULTS AND COSTS OF
BEAVERHEAD NATIONAL FOREST SURVEY - 1931

Items	Unit Strip (1)	Man-Days on Project			Total
		Check Strip (2)	Office	Ineffec- tive	
Man-days spent on survey	180	20	26½	62½	289
Miles of sample strip					1,531.2
Miles of strip per man-day	8.51				5.30
No. of sample strip acres					12,249.6
No. of sample strip acres per man-day	56.8				35.4
Acres covered by survey					1,415,340
Acres surveyed per man-day	7,860				4,895
<u>Total Cost of Survey</u>					
Labor					\$ 1,614.36
Transportation					178.00
Subsistence					551.76
Equipment					33.00
Telephone and telegraph					4.75
					<u>\$ 2,381.87</u>
<u>Cost of Survey Distributed</u>					
Cost per man-day					\$ 8.25
Cost per mile of strip					1.56
Cost per sample acre					.194
Cost per acre of region surveyed					.0017
Per cent of total area actually covered by survey					.87
Total meals in camp					418
Total cost of meals in camp					\$ 165.50
Cost per meal					.396

(1) Consists only of the strip run on the units to determine the amount of infestation.

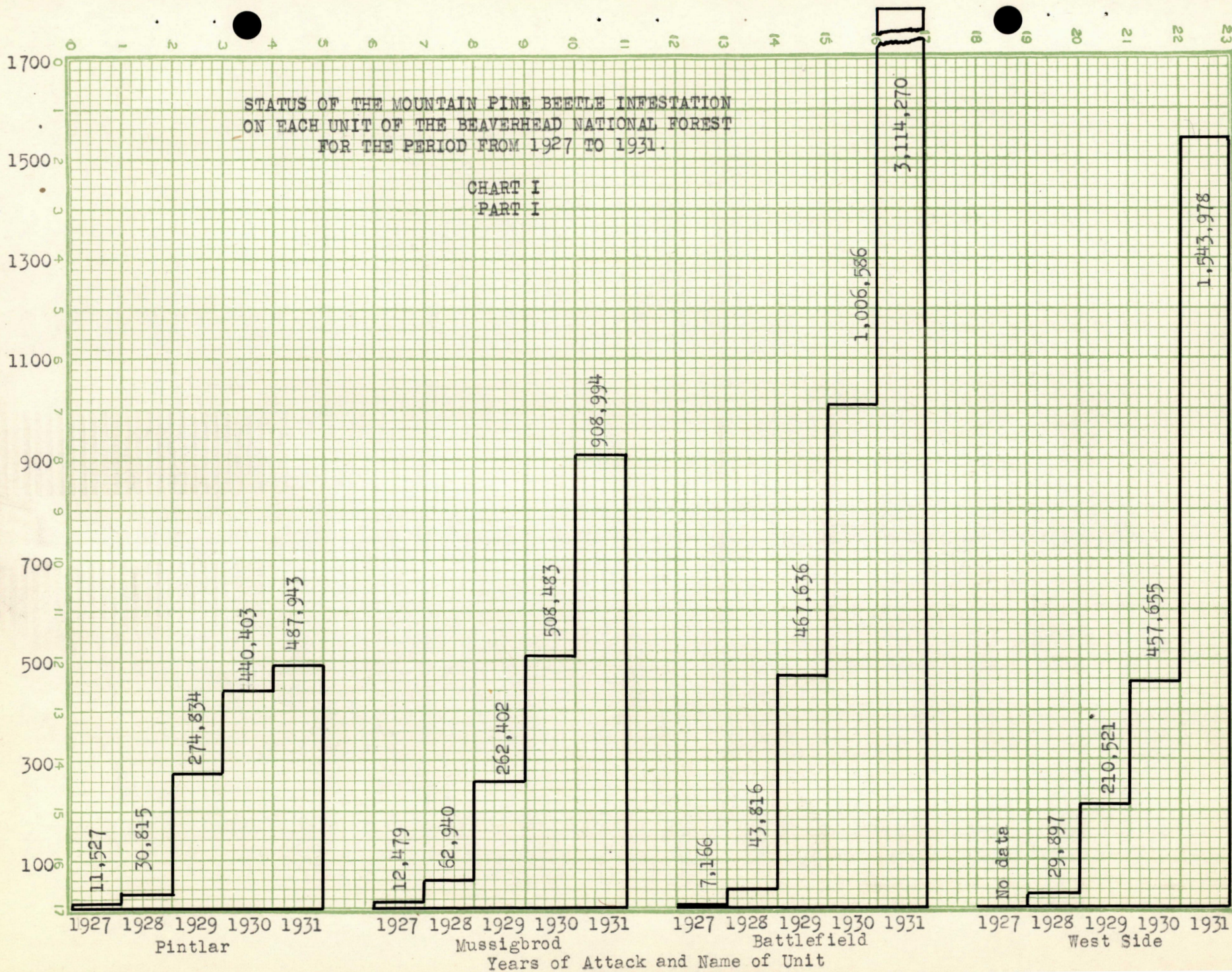
(2) Includes the two strips repeatedly examined to determine the amount of attack for different periods.

Ineffective time includes the following: travel time 33½ man-days, sickness 2 man-days, inclement weather 18 man-days, conference 1 man-day, car repair 3 man-days, checking work 1 man-day, mapping, scouting, etc. 3 man-days, supplies 1 man-day.

STATUS OF THE MOUNTAIN PINE BEETLE INFESTATION
ON EACH UNIT OF THE BEAVERHEAD NATIONAL FOREST
FOR THE PERIOD FROM 1927 TO 1931.

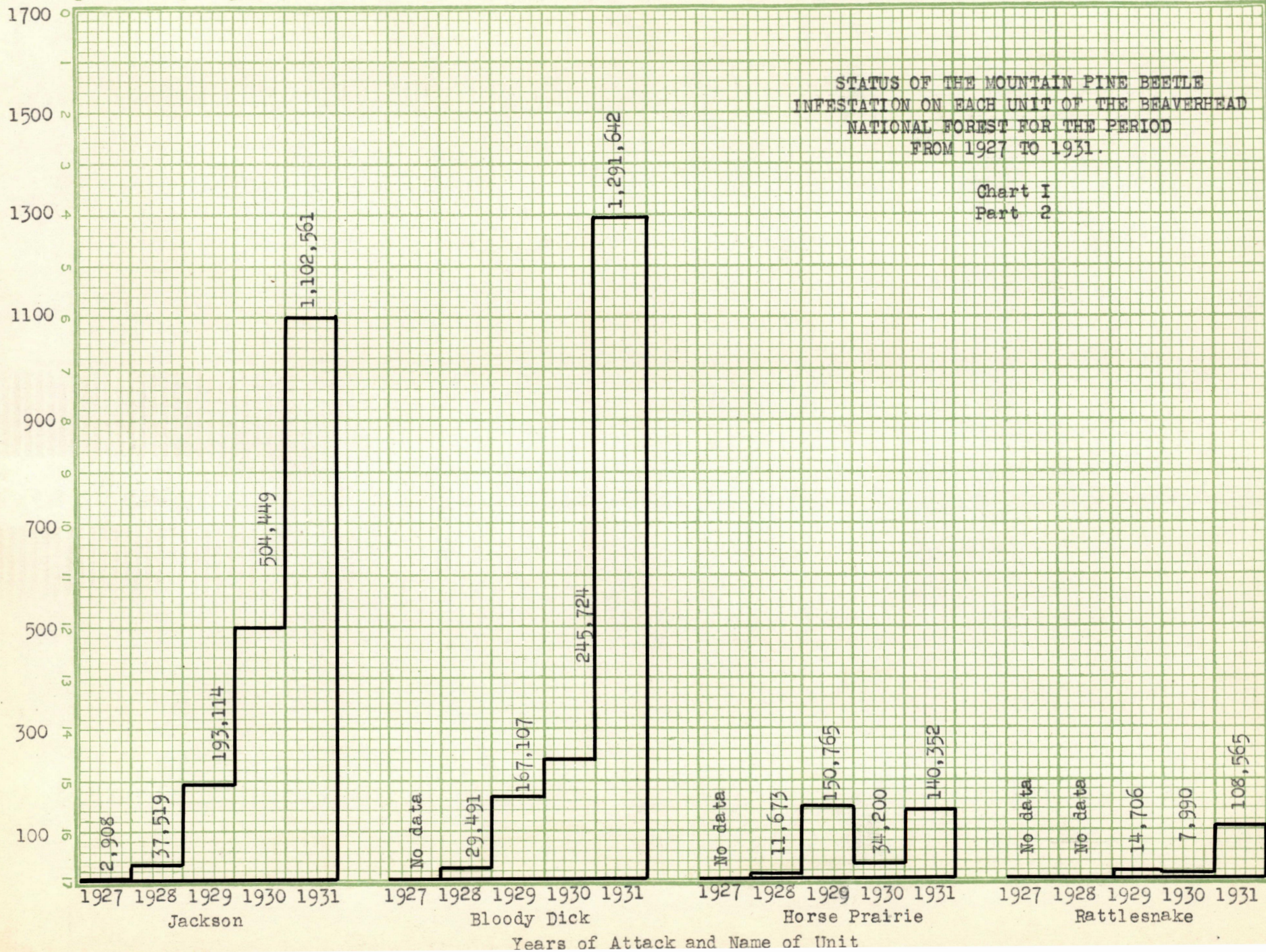
CHART I
PART I

Thousands of Attacked Trees



STATUS OF THE MOUNTAIN PINE BEETLE
INFESTATION ON EACH UNIT OF THE BEAVERHEAD
NATIONAL FOREST FOR THE PERIOD
FROM 1927 TO 1931.

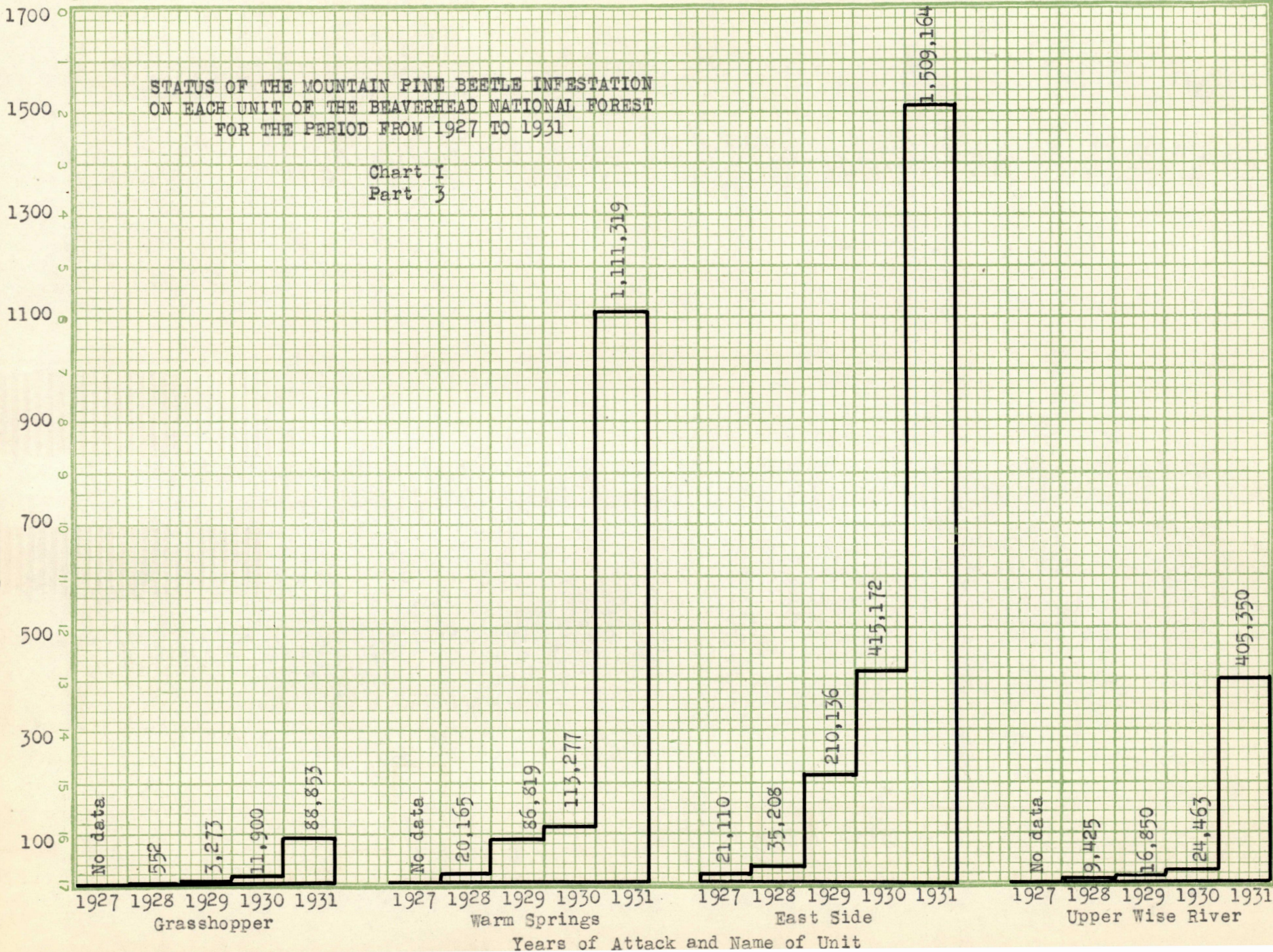
Chart I
Part 2



STATUS OF THE MOUNTAIN PINE BEETLE INFESTATION
ON EACH UNIT OF THE BEAVERHEAD NATIONAL FOREST
FOR THE PERIOD FROM 1927 TO 1931.

Chart I
Part 3

Thousands of Attacked Trees

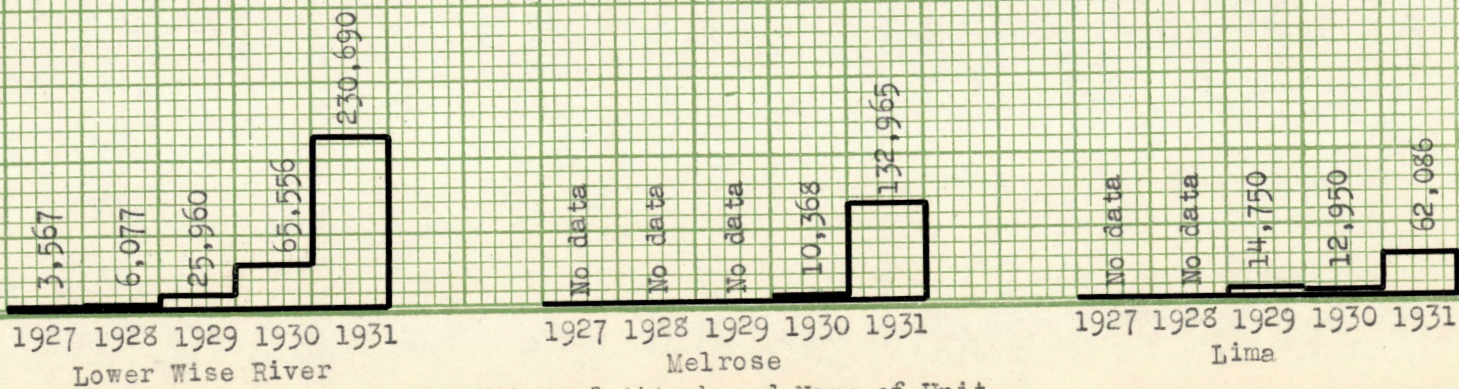


Thousands of Attacked Trees

1700
1500
1300
1100
900
700
500
300
100

STATUS OF THE MOUNTAIN PINE BEETLE INFESTATION
ON EACH UNIT OF THE BEAVERHEAD NATIONAL FOREST
FOR THE PERIOD FROM 1927 TO 1931

Chart I
Part 4



Years of Attack and Name of Unit

ESTIMATE OF THE PER CENT
OF THE FINAL NUMBER OF MOUNTAIN PINE BEETLE ATTACKED TREES
PRESENT ON THE BEAVERHEAD NATIONAL FOREST ON VARIOUS DATES
AS OBTAINED FROM THE REPEATED EXAMINATIONS
OF TWO SAMPLE STRIPS
1931

Chart II

Per Cent of Final Number of Attacks

